CHAPTER 13

CONTAINER PORTS

13-1. Planning.

a. Basic considerations. In container port design, the basic considerations are as follows:

(1) Open space is needed in large amounts.

(2) Railroads and trucks are both involved in feeding containers to the ship, and adequate space must be provided in the container yard for their operation.

(3) Some buildings are required, although the number and area will be quite limited compared with those for break-bulk general cargo terminals.

(4) Because of the large land area required, berths for containerships will be of the continuous bulkhead or wharf type of construction, rather than finger piers or dolphin-type construction.

(5) Space will normally be required on the wharf for railroad tracks, operation of trailer and straddle trucks, and gantry cranes ranging from 25to 35-ton capacity for handling containers. Therefore, the wharf will generally be wider than for break-bulk general cargo terminals.

b. Containership berths. Containership berth is generally a marginal-type wharf backed up by ample land for the operation. The design of the wharf is little different than that of any other wharf except for the following features:

(1) Containerships are becoming larger than general cargo ships, requiring berths up to 900 to 1,000 feet long, whereas a 500to 600-foot berth will serve most general cargo ships.

(2) Provision must be made in the design of the deck for the support of the front gantry crane rail and possibly for the rear rail unless the gage is very wide. Because of the heavy loads to be lifted (up to 40 tons) and the long reach to load the far side of the ship (up to 110 feet), the wheel loads are very heavy, usually 100 to 115 kips on 4-foot centers.

(3) The design live load is usually heavier than for break-bulk general cargo wharves, being 800 to 1,000 pounds per square foot, and the deck slab will normally have to be designed for the heaviest trailer truck wheel loads and for railroad wheel loads when the railroad is placed on the wharf.

(4) Because of the high live load that can occur in back of the wharf, the structure must be designed for a relatively large horizontal surcharge load.

(5) Because of the prevailing method of handling the containers on and off the ship by movable gantry cranes on the wharf, except for a few ships equipped with their own gantries and for the roll-on/roll-off container type of operation, it is desirable that all the berths in a terminal be in a straight line.

c. Storage and marshaling area. The design criteria for storage and marshaling area are as follows: (1) One modern container ship will hold ± one thousand 40-foot containers or equivalents. Based on commercially available materials handling equipment, approximately 12 acres of storage and marshaling area, including area for trailer chassis, will be required for off-loading one of the newer container ships. (fig. 13-1)

(2) Each storage and marshaling area should be designed to accommodate one of the most suitable types of commercial Materials Handling Equipment (MHE), which appeared to be either the heavy duty front loader, the side loader, or straddle carrier, in conjunction with the trailer chassis.

(3) Substantial amounts of base course and pavement surfacing must be provided each storage and marshaling area, otherwise failures can be expected from the loads exerted by either the loaded MHE or stacked containers, or possibly more so by combinations of each. Surfacing requirements are contained in appendix B.

(4) Most modern MHE needs to have the capability of stacking fully loaded 40-foot containers (67,200 pounds) three high; however, only two-high stacking is recommended due to additional weight and maintenance of pavement surface.

(5) Empty containers will not be stacked over three high unless wind screening is provided.

(6) Commercial storage and marshaling areas should be located as near the off-loading pier as possible. This could be a problem for military storage and marshaling areas because of the potential of enemy action damaging or destroying both structures at the same time.

(7) The surface gradient of the storage and marshaling areas should be as small as adequate drainage will allow so that stacked containers can be accommodated more efficiently.

(8) The placement of each container should be according to its scheduled movement from the storage and marshaling area.

d. Railroad and truck operation.

(1) *Provision for railroad operation*. Container

ports may be provided with double-track sidings from a train makeup yard, which preferably should be outside the container yard. This railroad configuration should run the length of the wharf apron, with sufficient crossovers, so that empty or reloaded cars can be switched onto the outgoing track. Instead of the tracks running on the wharf, they may be located in back of the wharf, within reach of the inboard extension of the gantry crane bridge. A railway spur shall also run down one of the longitudinal aisles in the marshaling and storage yard so that a yard gantry crane, straddle truck, or forklift truck can transfer containers to and from the flatbed railway cars.

(2) Provision for truck operations. Container terminals should have provision for truck traffic. It is important in the location of a container facility that it be near main highway arteries. Traffic congestion may occur where the trailer trucks pass the control office. To prevent trailer truck traffic from blocking public highways leading to or passing by the container yard, adequate length of roadway or parking area should be provided inside the main entrance to the marshaling yard ahead of the control office. A Circumferential road may lead to the wharf to maintain through traffic along the wharf and not require turning on the apron. Longitudinal aisles may be provided between double rows of parked containers, stored on trailers, leading to transverse collecting aisles to the wharf. Aisles will normally be about 60 feet wide. AU areas within a container yard need to be paved and drained so that ponding will not take place. Subgrade conditions need to be carefully investigated, and pavements designed for the concentrated wheel loads; or when containers are placed on the ground, the loads will be concentrated at the corners. Excessive loads may result from containers being stacked too high.

13-2. Types of container operations.

Two completely different types of container operations have been developed. The two methods are identified by the way the ship is loaded and unloaded and are commonly referred to as lift-on container operation and roll-on-roll-off (ro-ro) operation.

a. Lift-on container operation. This operation is by far the most common type. In general, the two principal systems of lift-on operation are as follows:

(1) Inbound and outbound containers are stored in the marshaling yard on standard over-the-road chassis. Incoming containers are weighed, checked in, and dispatched to a predetermined parking location in the marshaling yard. The over-the-road tractor either picks up a container and chassis or returns to its operations base empty. Yard tractors haul both exported and imported containers between the marshaling yard and the wharf. At the wharf, gantry cranes, either on the ship or on the wharf, lift export containers off the chassis and on board the ship, remove import containers from the hold, and place them on the tractor-driven chassis, which then returns to the marshaling yard.

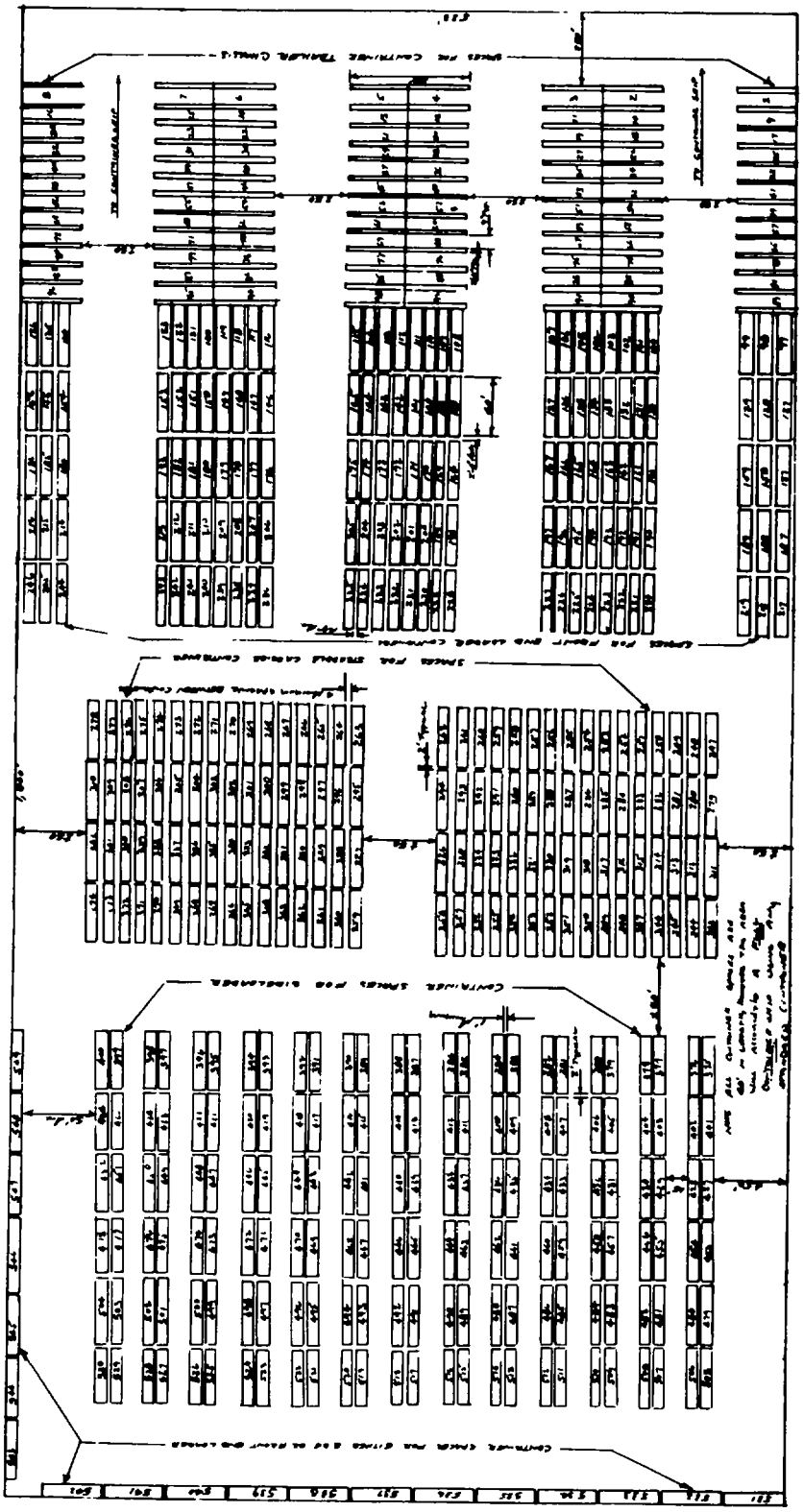
(2) This system has the containers stored on the ground in the marshaling yard and serviced by straddle or forklift trucks. As an export container arrives, it is received in the marshaling yard, and a straddle truck removes the container from its chassis and moves it to its storage place on the ground or on top of another container, if stacked two high. The straddle truck loads the container on a yard tractor trailer for delivery to the dock, where it is loaded on board the ship. Import containers unloaded from the ship are carried to the marshaling yard by the tractor trailer, and the straddle truck moves them to their place in storage. When the containers are ready for delivery, the straddle truck places them on and over-the-road tractor and chassis.

b. Roll-on/roll-off operation. As the name implies, this operation differs from the lift-on container operation in that tractors deliver their trailers on wheels on board the ship, where they are detached from the tractor and secured to the deck. Then the tractor returns to shore to pick up another trailer. The operation of loading and unloading goes on simultaneously. More detailed discussion of roll-on roll-off operation is given in chapter 12.

13-3. Container handling equipment.

a. Efficient handling of large containers requires special equipment on the ship or on the wharf, the latter being the preferred method since it permits the gantry crane to reach a considerable distance inland as well as over the ship. A typical wharf-side traveling gantry crane is shown in figure 12-3.

b. When rehandling is necessary on land, this is accomplished by means of giant straddle carriers (fig B-3). Front loading container handlers (fig B-5) are also used and can stack the container three high. A heavy-duty side-loading container handler (fig B-7) can handle 40-foot containers two high. Likewise, the gantry cranes, on either rails or rubber tires (fig B-8), can stack containers four high on the ground, then pick them up and place them on a railroad flatcar or truck chassis.



by U.S. Army Engineer
Waterways Experiment Station

Figure 13-1. Recommended container storage and marshaling area